# Immediate analgesic effect of interferential and Aussie currents in chronic low back pain: randomized clinical trial

*Efeito analgésico imediato das correntes interferencial e Aussie na dor lombar crônica: ensaio clínico randomizado*

Lauana de Paula[1], Ayla Colmenarez[2], Felipe Vieira França[2], Filipe Teruo Yamada[2], Nicole Tafarello[2], Ana Carolina Brandt de Macedo[2]

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## ABSTRACT

**BACKGROUND AND OBJECTIVES:** Despite the widespread use of mid-frequency currents in reducing pain in chronic low back pain (CLBP), there is still no consensus on the optimal parameters for treatment. The aim of this study was to compare the immediate analgesic effects of interferential (IC) and Aussie (AC) currents in CLBP.

**METHODS**: This is a five-arm double-blind randomized controlled trial. Patients aged between 18 and 60 years with CLBP were randomly divided into 5 groups: CI4kHz/100Hz, CI4kHz/2Hz, CA4kHz/100Hz, CA4kHz/2Hz and placebo (PG). Participants received a single application of Interferential current or Aussie current for 30 min. Main outcome measures were pain intensity by numeric pain scale (NPS), McGill pain questionnaire (MPQ) and pressure pain threshold. The secondary outcomes assessed were: abdominal strength test (AST), lumbar flexion test (modified Schober test), trunk and lower limb mobility (sit and reach test and finger tip test).

**RESULTS**: There was a significant difference in NPS and MPQ groups (with the exception of the affective component) ($p<0.05$) in IC 4 kHz/100 Hz and IC 4 kHz/2 Hz groups in relation to PG. Regarding secondary outcomes, a difference was found only between IC 4kHz/2Hz and PG in AET.

**CONCLUSION:** Interferential current, regardless of frequency modulation, provided immediate analgesic effect in individuals with CLBP, being superior to the effects of Aussie current.


**Keywords:** Pain, Low back pain, Pain measurement, Transcutaneous electrical nerve stimulation.


## RESUMO

**JUSTIFICATIVA E OBJETIVOS**: Apesar da grande utilização das correntes de média frequência na diminuição do quadro álgico na dor lombar crônica (DLC), ainda não existe consenso sobre os parâmetros ideais para tratamento. O objetivo deste estudo foi comparar os efeitos analgésicos imediatos das correntes interferencial (CI) e Aussie (CA) na DLC.

**MÉTODOS**: Trata-se de um ensaio clínico randomizado controlado duplo-cego de cinco braços. Foram selecionados pacientes com idades entre 18 e 60 anos, com DLC, que foram divididos aleatoriamente em 5 grupos: CI4kHz/100Hz, CI4kHz/2Hz, CA4kHz/100Hz, CA4kHz/2Hz e placebo (GP). Os participantes receberam uma única aplicação da corrente Interferencial ou corrente Aussie durante 30 min. As principais medidas de desfechos foram: intensidade da dor pela escala numérica da dor (END), questionário de dor McGill (QDM) e limiar de dor por pressão (LDP). Os desfechos secundários avaliados foram: teste de resistência abdominal (TRA), teste de flexão da lombar (teste de Schober modificado), mobilidade de tronco e membros inferiores (teste de sentar e alcançar e teste de distância do terceiro dedo ao solo).

**RESULTADOS**: Houve diferença significativa nos grupos END e QDM (com exceção do componente afetivo) ($p<0,05$) nos grupos CI 4 kHz/100 Hz e CI 4 kHz/2 Hz em relação ao GP. Com relação aos desfechos secundários foi encontrada diferença somente entre CI 4kHz/2Hz e GP no TRA.

**CONCLUSÃO**: A corrente interferencial, independente da modulação da frequência, proporcionou efeito analgésico imediato em indivíduos com DLC, sendo superior aos efeitos da corrente Aussie.


**Descritores**: Dor, Dor lombar, Estimulação elétrica nervosa trasncutânea, Mensuração da dor.

## INTRODUCTION

Chronic low back pain (CLBP) can be defined as pain or discomfort located below the last rib and above the iliac crest in the lumbosacral region lasting three months or more[1]. LBP is

Lauana de Paula – https://orcid.org/0000-0001-5214-2519;
Ayla Colmenarez – https://orcid.org/0009-0004-6303-1418;
Felipe Vieira França – https://orcid.org/0009-0008-8546-0124;
Filipe Teruo Yamada – https://orcid.org/0009-0001-7296-3880;
Nicole Tafarello – https://orcid.org/0009-0000-7709-7742;
Ana Carolina Brandt de Macedo – https://orcid.org/0000-0002-1514-7887.

1. Federal Technological University of Paraná, Strictu Sensu Postgraduate Program in Physical Education, Curitiba, PR, Brazil.
2. Federal University of Paraná, Department of Prevention and Rehabilitation in Physiotherapy, Curitiba, PR, Brazil.

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**HIGHLIGHTS**

- Mid-frequency currents provided immediate analgesic effect in subjects with chronic low back pain.
- Interferential current decreased pain and improved functionality in subjects with chronic low back pain.
- The analgesic effect of interferential current was superior to that of Aussie current.

**Correspondence to:**
Ana Carolina Brandt de Macedo
**E-mail**: acbrandtmacedo@gmail.com

a common clinical condition with both physical and psychosocial repercussions[2]. According to the Global Burden of Disease[3], LBP generates numerous cases of disability in many regions of the world. Thus, this condition is capable of inhibiting people's ability to perform different types of work inside and outside the home, impairing their mobility and functionality.

Electrical currents are used for pain control and among them are the Interferential and Aussie currents[4,5]. Interferential current (IC) is a medium-frequency, low-frequency modulated electric current that is able to penetrate deeper into tissues compared to other low--frequency currents[6]. On the effect of IC on pain management in patients with CLBP, one study concluded that it provides positive effects on pain and functionality[7]. A narrative review[4] also showed significant pain reduction in patients with neck pain, low back pain, knee osteoarthritis and postoperative knee recovery after IC treatment, but the authors mention that the modulation of parameters remains inconclusive, as well as its mechanism of action. Studies evaluating its immediate analgesic effects are still scarce, with a reduction in pain observed shortly after application. However, there is still no consensus regarding the ideal treatment parameters[6,8-11].

The Aussie current (AC) is defined as an alternating electric current of medium frequency (1kHz to 4kHz), which can be modulated at low frequency, being more comfortable when compared to other currents due to its burst, which is adapted to a shorter duration[5,12]. Rampazo da Silva et al.[13] compred the segmental and extra-segmental hyperalgesic effects of interferential, transcutaneous electrical nerve stimulation (TENS) and Aussie (4 kHz, 100 Hz, 4 ms burst, 30 min) currents, and concluded that segmental and extra-segmental hyperalgesic effects are obtained in all the currents investigated, however without differences between them. Although one of the effects of AC is analgesic, there are still few studies on its effects in patients with CLBP. One study[12] applied AC for strengthening (1 kHz, modulated at 50 Hz and burst duration of 4 ms, motor level intensity) in women with CLBP and found a reduction in pain when compared to the control group. However, there are still no studies that used Aussie current with analgesic objective in patients with CLBP.

Studies comparing the analgesic effect of IC and AC in CLBP are scarce, thus the primary objective of the present study was to compare the immediate analgesic effect of IC and AC in subjects with CLBP and the secondary objective was to evaluate abdominal endurance, lumbar spine flexion and trunk and lower limb mobility.

## METHODS

This is a 5-arm, double-blind, randomized controlled trial, which was approved by the Ethics and Research Committee of the Federal University of Paraná (*Comitê de Ética e Pesquisa da Universidade Federal do Paraná* - CAEE: 44642615.2.0000.0102) and prospectively registered in the Brazilian Registry of Clinical Trials (*Registro Brasileiro de Ensaios Clínicos* - ReBEC: RBR-59Y-GR). This study followed the Consolidated Standards of Reporting Trials (CONSORT) recommendations.

### Eligibility criteria

The following inclusion criteria were established to participate in the study: individuals of both sexes, aged between 18 and 60 years, complaining of nonspecific LBP (>12 weeks)[14] and reporting pain intensity greater than 3 according to the numerical pain scale (NPS)[15]. Exclusion criteria were patients with a history of surgery in the lumbar and abdominal spine, disc herniation, without a report of low back pain at the time of evaluation, with pain less than 3 on NPS and/or who had taken anti-inflammatory and/or analgesic drugs 24 hours before the evaluation.

Participants were invited verbally and through social media and those who met the inclusion criteria and agreed to participate signed the Free and Informed Consent Term (FICT) - Resolution 466/2012 of the Brazilian National Health Council (*Conselho Nacional de Saúde*).

### Sample size

The G*power 3 3.1.0 software was used to calculate the sample size, considering two points of difference in NPS with a standard deviation of 1.47 points. The power of the test was 80%, sample loss 20% and 5% significance level. Therefore, 25 participants were included in each group, totaling 125 in this study.

### Outcomes

First, the participant's identification data were collected and anamnesis was taken. Then, pain was assessed by NPS, the McGill pain questionnaire (MPQ) was applied and the pressure pain threshold (PPT) was recorded by algometry. The Start Back Screening Tool (SBST) questionnaire (control variable) was also applied to verify the influence of psychosocial factors on low back pain. The following musculoskeletal tests were also performed: abdominal strength test (AST), lumbar spine flexion test (modified schober test - MST) and trunk and lower limb mobility tests (sit and reach test - SRT - and finger tip test - FTT). All questionnaires and tests were performed prior to the application of the current and immediately afterwards.

### Pain assessment

*Intensity of pain*

NPS is a ruler that goes from zero to 10, with zero being no pain and 10 being unbearable pain. In this test, the individual was instructed to point on the ruler the number that represented their pain at the time of evaluation[16].

*McGill pain questionnaire*

This questionnaire presents 78 adjectives (descriptors) about pain, which are separated into 4 groups (sensory discriminative, mixed, affective emotional, cognitive evaluative) and 20 subcategories. The participant had to choose within these groups one or none of the words that best described their pain. The total numerical index of adjectives was calculated by the number of words that patients chose in each subcategory[17,18]. The number of words chosen in each group was also verified.

*Pressure pain threshold*

The algometer instrument (EMG system®, Brazil) was used to evaluate PPT. To measure low back pain, 4 points were marked: 5 cm from the 3rd lumbar vertebra (L3) and the fifth lum-

bar vertebra (L5), one point on the left and right of each. Two points were also marked for control, located laterally on the right and left legs under the tibialis anterior muscle at 4 cm from the midpoint of the tibia. The algometer was pressed perpendicularly to the points and the subject was instructed to say "stop" or "enough" when they could no longer bear the pressure.

The pressure on each point was performed three times with an interval of one minute between each, starting with the points on the legs and then on the lumbar, in the following order: left of L3, right of L3, left of L5, right of L5[8]. After the process, the arithmetic mean was made to find the pain threshold. This evaluation was done before and after the intervention to compare the patient's pain level, by the same examiner who was previously trained (CI=0.98).

**Assessment of biopsychosocial aspects**

The Start Back Screening Tool was used to verify the influence of biopsychosocial factors on low back pain and classify them into one of three groups: high risk (high level of psychosocial factors with or without physical factors), medium risk (with psychosocial and physical factors, but lower than in high-risk patients) and low risk (with minimal psychosocial and physical factors). In this questionnaire, items were presented with questions related to pain and the person's daily life, with predetermined answers in agreeing or disagreeing with the statements. If the total score was less than 3, the patient was considered low risk. For patients with a score greater than 3, the number of questions selected from questions 5-9 was calculated; if the number of selected questions was equal to or less than three, the patient was considered medium risk and if it was greater than 3, it was considered high risk[19].

**Musculoskeletal test**

*Abdominal strength test*

The test was started with the patient supine on a mat, with feet supported, heels together and knees flexed at 140°. In this position, the patient positioned the arms extended along the thigh with the fingers pointed towards the knee. The execution of the movement was initiated from the active contraction of the abdominal muscles, lifting the shoulders and head from the mat. The patient performed the movement in a controlled and slow manner, establishing the rhythm of 20 executions per minute with the aid of the metronome. If the patient felt great discomfort, was unable to perform the movement correctly, the heels lost contact with the mat or the individual stopped performing the movement, the test was terminated. The number of executions performed was verified[20].

**Trunk and upper limb mobility tests**

*Sit and reach test*

In SRT the patient was positioned seated with the lower limbs extended and with the soles of the foot resting on a bench (Wells Bench). After that, the patient was instructed to place his hands on the top of the bench and flex his trunk as much as he could with his legs straight and maintain the position for three seconds. The test was performed three times and the best result was used[21].

*Finger tip test*

This test assessed trunk and lower limb mobility. The patient was asked, in bipedestation with the feet together on a 20cm high platform, to flex the trunk as far as he could with the knees, arms and fingers extended. Thus, the distance in centimeters between the tip of the finger and the floor was measured using a tape measure[22].

*Lumbar spine flexion test*

To assess lumbar flexion, the modified Schober test (MST) was performed. The spinous process of the first sacral vertebra (S1) was first marked, then 10 cm above and 5 cm below. The patient was asked to flex the trunk anteriorly as far as possible without flexing the knees. The distance between the marked points after trunk flexion was recorded[23].

**Randomization**

Randomization was performed using the block methodology by means of an envelope containing 25 papers: IC 4 kHz/100 Hz - 5 papers, IC 4 kHz/2 Hz - 5 papers, AC 4 kHz/100 Hz - 5 papers, AC 4 kHz/2 Hz - 5 papers and PG - 5 papers. Thus, the draw was performed blindly for both the evaluators and the participant, so that a third person was responsible for the draw and application of the device, not being responsible for the evaluation.

**Intervention**

Participants were divided into 5 groups: IC 4 kHz/100 Hz, IC 4 kHz/2 Hz, AC 4 kHz/100 Hz, AC 4kHz/2Hz and PG.

For the application of both IC and CA, the participant was instructed to lie in the prone position. Four silicone-carbon electrodes (90x50 mm) with conductive gel and an adhesive tape to fix them were positioned crosswise in the lumbar region. In the IC the type of application was static tetrapolar, with AMF variation of 0 Hz, without slope. In both currents, the electrodes were placed crosswise, at a distance of 5 cm to right and left of the spinous process of the 3rd lumbar vertebra (L3) and the 5th lumbar vertebra (L5).

The study used the Neurodyn equipment from IBRAMED, which was previously calibrated, and the currents were applied for 30 minutes in each group, being parameterized as follows:

- IC 4 kHz/100 Hz and AC 4 kHz/100 Hz: in both currents (interferential and Aussie) the pulse frequency (PF) used was 4 kHz, being modulated at 100 Hz, and the intensity used at sensory level;
- IC 4 kHz/2 Hz and AC 4 kHz/2 Hz: FP was 4 kHz, modulated at 2 Hz and with intensity at motor level.
- In PG, the equipment was turned on, but no value was parameterized and the intensity was not increased, so the participant was in prone position with the electrodes in the lumbar region for 30 minutes. It should be noted that the applications were always performed by the same researcher, who always established the same explanation about the current procedures, regardless of the way it would be applied.

**Statistical analysis**

Statistical analysis was performed using SPSS 25.0 software, adopting results expressed as mean±standard deviation, performing the Shapiro Wilk test for normality analysis and the Levene test for analysis of variance homogeneity. For parametric variables, repeated measures analysis of covariance (ANCOVA) was used for intragroup and intergroup comparisons, using the Start Back Screening Tool as a covariate. The Wilcoxon and Kruskall-Wallis tests were also used for intragroup and intergroup analysis, respectively, in non-parametric variables. In general, this study considered $p<0.05$ to be statistically significant.

## RESULTS

A total of 125 patients were recruited between August 2018 to March 2022 and divided into five groups: IC 4 kHz/100 Hz (n=25), IC 4 kHz/2 Hz (n=25), AC 4 kHz/100 Hz (n=21), AC 4 kHz/2 Hz (n=21) and PG (n=21) (Figure 1). Four participants from each Aussie current group and four from placebo group did not complete the study and therefore the final sample size was 113 participants. The numerical difference between the groups was due to the fact that the individuals did not fit the inclusion criteria of the research, i.e. they did not have NPS>3.

**Data description**

Table 1 presents the physical and sociodemographic characteristics of the study population. The mean age of the participants was 32.96±15.96 years; being composed of 61 women (54%) and 52 men (46%). Most participants had incomplete higher education (50.4%, n=57), were non-smokers (89.4%, n=101), non-alcoholist (77%, n=87) and sedentary (54.9%, n=62).

Participants had an average of 4.68 months of pain, predominantly gradual onset (70.8%, n=80). The majority of participants reported centralized pain (38.1%, n=43), with worsening in the evening (52.2%, n=59). A total of 37 participants (32.7%) reported pain on walking; 54 on sitting (47.8%); 64 on stooping (56.6%); 53 on standing (46.9%); 35 on climbing stairs (31%), and the majority (90.5%, n=102) reported pain on exertion.

In SBST the majority of participants were considered low risk (40.7%, n=46), followed by high risk (37.2%, n=42).

Table 2 presents the results of the intra-group analysis. A $p>0.05$ was found in the ShaproWilk and Levene tests and therefore the Wilcoxon test was performed. It was found that IC 4 KHz/100 Hz showed significant difference in all pain outcomes and related to functional tests. On the other hand, the other groups, IC 4 KHz/2 Hz, AC 4 KHz/100 Hz, AC 4 KHz/2 Hz and PG, presented statistically significant differences in NPS and in all MPQ groups, with the exception of miscellaneous in PG and also in the total index. The groups that were submitted to AC did not present significant difference in PPT, as well as PG. As for the functional tests, a significant difference was found in at least one test both in IC 4 KHz/2 Hz (abdominal resistance test) and in AC 4 KHz/100 Hz (third finger test to the ground), AC 4 KHz/2 Hz (sit and reach test). No significant difference was found in PG.

Figure 2 shows the intergroup analysis of NPS and MPQ. It was found that both IC groups, regardless of modulation (100 Hz or 2 Hz), showed a significant difference ($p<0.05$, Kruskall-Wallis) in relation to PG in almost all variables, except for MPQ affective group. AC did not show a significant difference with PG in any of these outcomes.

In the intergroup analysis of algometry, no significant difference was found at any point in either group. Regarding the functional tests, only a significant difference was found in IC 4KHz/2Hz with PG in AST (Table 3).

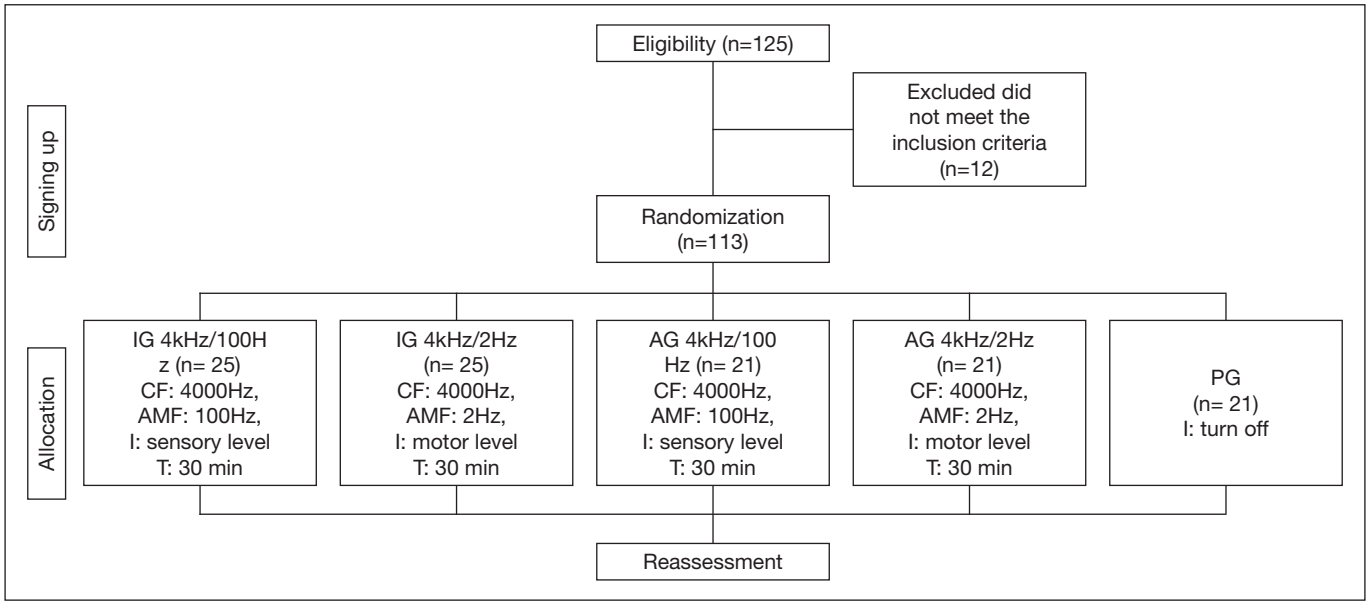


**Figure 1**. Study design

IG = interferential group; AG = Aussie group. CF = carrier frequency; AMF = amplitude modulation frequency; I = intensity; T = time.

**Table 1.** Clinical and sociodemographic characteristics

| | IC 4 KHz/100 Hz | IC 4 KHz/2 Hz | AC 4 KHz/100 Hz | AC 4 KHz/2 Hz | PG | p-value |
|---|---|---|---|---|---|---|
| Age (mean/±SD) | 33.16±16.6 | 41.6±18.9 | 35.5±16.6 | 23.8±7.94 | 28±10.8 | >0.05 |
| Gender (n°/%) | | | | | | |
| Female | 16 (64) | 11 (44) | 10 (47.6) | 12 (57.1) | 12 (57.1) | |
| Male | 9 (36) | 14 (56) | 11 (52.4) | 9 (42.9) | 9 (42.9) | |
| Education (n°/%) | | | | | | >0.05 |
| Incomplete elementary school | | | | | | |
| Complete elementary school | 2 (8) | 2 (8) | | | | |
| Incomplete high school | | | 1 (4.8) | 2 (9.5) | | |
| Complete high school | 5 (20) | 7 (28) | 6 (28.6) | | 4 (19) | |
| Incomplete higher education | 14 (56) | 8 (32) | 8 (38.1) | 17 (81) | 10 (47.6) | |
| Complete higher education | 4 (16) | 8 (32) | 6 (28.6) | 2 (9.5) | 7 (33.3) | |
| Lifestyle habits | | | | | | |
| Smoker (n°/%) | 3 (12) | 2 (8) | 1 (4.8) | 1 (4.8) | 5 (23.8) | |
| Alcoholist (n°/%) | 5 (20) | 7 (28) | 2 (9.5) | 9 (42.9) | 3 (14.3) | |
| Sedentary (n°/%) | 17 (68) | 11 (44) | 10 (47.6) | 4 (19) | 9 (42.9) | |
| Duration of pain (months) | | | | | | |
| (mean, minimum, maximum, median) | (3.2.0.20.2) | (7.2.0.40.3) | (5.9.1.20.3) | (3.6.1.10.3) | (3.1.1.6.3) | >0.05 |
| Location of pain (n°/%) | | | | | | |
| Centralized | 10 (40) | 5 (20) | 10 (47.6) | 6 (28.6) | 13(61.9) | |
| On the right | 3 (12) | 4 (16) | 6 (28.6) | 4 (19) | 3 (14.3) | |
| On the left | 2 (8) | 5 (20) | 3 (14.3) | 3 (14.3) | 2 (9.5) | |
| Bilateral | 10 (40) | 11 (44) | 2 (9.5) | 8 (38.1) | 3 (14.3) | |
| Period of the day that worsens pain (n°/%) | | | | | | |
| Morning | 4 (16) | 6 (24) | 8 (38.1) | 3 (14.3) | 7 (33.3) | |
| Afternoon | 3 (12) | 7 (28) | 4 (19) | 8 (38.1) | 4 (19) | |
| Night | 18 (72) | 12 (48) | 9 (42.9) | 10 (47.6) | 10(47.6) | |
| Activities that exacerbate pain (n°/%) | | | | | | |
| Walking | 9 (64) | 8 (32) | 8 (38.1) | 3 (14.3) | 9 (42.9) | |
| Sitting | 9 (64) | 10 (40) | 12 (57.1) | 11 (52.4) | 12(57.1) | |
| Lowering | 15 (60) | 12 (48) | 14 (66.7) | 11 (52.4) | 12(57.1) | |
| Raising | 11 (44) | 9 (36) | 10 (47.6) | 11 (52.4) | 12(57.1) | |
| Stair climbing | 9 (36) | 9 (36) | 7 (33.3) | 5 (23.8) | 5 (23.8) | |
| Effort | 22 (88) | 24 (96) | 17 (81) | 20 (95.2) | 19(90.5) | |
| Start Back | | | | | | |
| Low risk | 7 (28) | 6 (24) | 10 (47.6) | 12 (57.1) | 11(52.4) | |
| Medium risk | 10 (40) | 9 (36) | 1 (4.8) | 4 (19) | 1 (4.8) | |
| High risk | 8 (32) | 10 (40) | 10 (47.6) | 5 (23.8) | 9 (42.9) | |
| Pillow (n°/%) | | | | | | |
| Low | 4 (16) | 2 (8) | 8 (38.1) | 5 (23.8) | 5 (23.8) | |
| Medium | 9 (36) | 15 (60) | 11 (52.4) | 10 (47.6) | 10(47.6) | |
| High | 12 (48) | 8 (32) | 2 (9.5) | 5 (23.8) | 6 (28.6) | |
| Mattress (n°/%) | | | | | | |
| Suitable | 10 (40%) | 18 (72) | 17 (81) | 18 (85.7) | 16(76.2) | |
| Not suitable | 15 (60%) | 7 (28) | 4 (19) | 3 (14.3) | 5 (23.8) | |
| Supplementary Examination (n°/%) | | 2 (8) | | 1 (4.8) | | |
| Position at work (n°/%) | | | | | | |
| Standing | 12 (48) | 1 (4.8) | 4 (19) | 2 (9.5) | 1 (4.8) | |
| No position | 12 (48) | 7 (33.3) | 8 (38.1) | 1 (4.8) | 7 (33.3) | |
| Sitting | 13 (61.9) | 17 (68) | 9 (42.9) | 18 (85.7) | 13 (61.9) | |
| Onset of pain (n°/%) | | | | | | |
| Sudden | 5 (20) | 8 (32) | 6 (28.6) | 5 (23.8) | 9 (42.9) | |
| Gradual | 20 (80) | 17 (68) | 15 (71.4) | 16 (76.2) | 12 (57.1) | |
| BMI (kg/m²) | | | | | | |
| Underweight < 18.5 | | 3 (12) | 1 (4.8) | 1 (4.8) | 1 (4.8) | |
| Ideal weight between 18.6 and 24.9 | 12 (48) | 9 (36) | 10 (47.6) | 15 (71.4) | 13 (61.9) | |
| Overweight between 25.0 and 29.9 | 7 (28) | 7 (28) | 7 (33.3) | 4 (19) | 5 (23.8) | |
| Obesity grade I 30.0 to 34.9 | 6 (24) | 3 (12) | 3 (14.3) | 1 (4.8) | 1 (4.8) | |
| Obesity grade II 35.0 to 39.9 | | 2 (8) | | | | |
| Obesity grade III > 40.0 | | 1 (4) | | | 1 (4.8) | |

IC = Interferential Current Group; AC = Aussie Current Group; PG = Placebo Group.

**Table 2.** Pain assessment and musculoskeletal tests (intra-group).

| | IC 4 kHz/100 Hz (n=25) | | IC 4 kHz/2 Hz (n=25) | | AC 4 kHz/100 Hz (n=21) | | AC 4 kHz/2 Hz (n=21) | | PG (n=21) | |
|---|---|---|---|---|---|---|---|---|---|---|
| mean ±SD (min;max;-med) | Before | After | Before | After | Before | After | Before | After | Before | After |
| NPS | 5.80±1.29 (3;8;6) | 0.64±0.95 (0;3;0) | 6.44±1.66 (3;10;6) | 31.48±1.41 (0;4;1) | 5.33±1.35 (3;7;6) | 2.3±1.88 (0;5;2) | 4.33±1.56 (3;8;4) | 1.52±1.69 (0;5;1) | 4.45±0.99 (3;7;5) | 2.76±1.81 (0;7;3) |
| p-value | 0.001* | | 0.001* | | 0.001* | | 0.001* | | 0.001* | |
| MPQ | | | | | | | | | | |
| Sensory | 7.88±1.90 (3;10;8) | 1.56±2.56 (0;10;1) | 8.60±1.38 (6;10;9) | 2.72±3.00 (0;10;2) | 7.24±3.22 (1;10;9) | 4.38±4.22 (0;10;3) | 7.81±2.08 (2;10;8) | 3.81±4.02 (0;10;3) | 8.00±2.34 (2;10;9) | 5.67±3.54 (0;10;7) |
| p-value | 0.001* | | 0.001* | | 0.001* | | 0.001* | | 0.001* | |
| Affective | 3.16±1.54 (1;5;3) | 0.20±1.00 (0;5;0) | 3.80±1.63 (0;5;5) | 0.76±1.48 (0;5;0) | 3.43±1.9 6 (0;5;5) | 1.52±2.06 (0;5;0) | 3.14±1.52 (1;5;3) | 1.05±1.85 (0;5;0) | 3.48±1.38 (0;5;3) | 1.43±1.98 (0;5;0) |
| p-value | 0.001* | | 0.001* | | 0.001* | | 0.001* | | 0.001* | |
| Evaluative | 1.04±0.20 (1;2;1) | 0.12±0.33 (0;1;0) | 0.0±0.0 (0;0;0) | 0.24±0.43 (0;1;0) | 0.95±0.21 (0;1;1) | 0.57±0.50 (0;1;1) | 0.95±0.21 (0;1;1) | 0.48±0.51 (0;1;0) | 0.95±0.21 (0;1;1) | 0.71±0.46 (0;1;1) |
| p-value | 0.001* | | 0.001* | | 0.001* | | 0.001* | | 0.001* | |
| Miscellaneous | 2.56±1.08 (0;4;3) | 0.24±0.83 (0;4;0) | 3.36±0.86 (1;5;3) | 0.84±1.24 (0;4;0) | 2.90±1.21 (0;4;3) | 1.57±1.59 (0;4;1) | 2.52±1.56 (0;4;3) | 0.81±1.40 (0;4;0) | 2.38±1.46 (0;4;3) | 1.90±1.75 (0;4;1) |
| p-value | 0.001* | | 0.001* | | 0.001* | | 0.001* | | 0.25 | |
| MPQ Total | 14.76±3.95 (6;14;15) | 2.00±4.21 (0;20;5) | 16.76±3.37 (10;20;17) | 4.56±5.74 (0;18;2) | 14.52±6.40 (2;20;19) | 7.57±7.6 3 (0;20;4) | 14.48±4.53 (3;20;14) | 5.57±6.97 (0;20;2) | 14.81±4.75 (3;20;16) | 9.38±7.11 (0;20;9) |
| p-value | 0.001* | | 0.001* | | 0.001* | | 0.001* | | 0.001* | |
| PPT | | | | | | | | | | |
| TAR | 3.49±1.34 (12.04;7.09;3.06) | 3.55±1.04 (2.02;6.4;3.31) | 3.90±1.36 (1.87; 7.25.3.4) | 3.90±1.40 (2.14;7.25;3.56) | 6.15±3.17 (1.76;13.77;5.12) | 6.19±3.60 (1.69;17.41;5.00) | 5.62±2.50 (2.09;13.16;5.99) | 6.11±3.08 (0.10;13.12;6.80) | 6.29±2.96 (1.83;12.90;6.42) | 6.33±3.21 (1.67;13.30;6.09) |
| p-value | 0.17 | | 0.61 | | 0.59 | | 0.17 | | 0.09 | |
| TAL | 3.74±1.16 (2.25;7.03;3.47) | 3.55±0.98 (1.87;5.51;3.71) | 3.65±1.069 (2.1;6.01;3.67) | 3.32±1.25 (2.11;6.56;3.67) | 6.29±3.78 (1.76;17.07;4.87) | 6.06±3.83 (1.56;19.03;4.80) | 5.53±2.42 (1.51;10.55;5.53) | 5.34±2.54 (0.10;10.83;5.70) | 6.29±3.2 (1.93;14.60;6.05) | 6.41±3.81 (1.21;16.40;6.40) |
| p-value | 0.63 | | 0.68 | | 0.87 | | 0.62 | | 0.52 | |
| L3L | 5.49±1.52 (1.71;7.31;2.94) | 4.05±1.86 (1.52;6.93;4.31) | 3.51±.0.95 (1.70;5.21;3.61) | 4.09±1.15 (1.76;6.67;3.94) | 5.26±2.22 (2.19;9.40;4.71) | 5.50±2.38 (2.00;11.74;4.64) | 4.35±2.13 (1.54;7.60;4.36) | 4.73±1.62 (2.44;7.58;4.25) | 4.30±1.77 (1.10;7.88;4.32) | 4.13±2.04 (0.95;8.35;4.10) |
| p-value | 0.04* | | 0.001* | | 0.43 | | 0.13 | | 0.13 | |
| L3R | 3.49±1.35 (1.69;6.60;3.17) | 4.02±1.27 (1.48;6.59;4.02) | 3.56±1.08 (1.56;5.50;3.63) | 4.05±1.06 (1.86;5.73;3.89) | 5.44±2.91 (1.32;11.73;4.27) | 5.63±2.75 (2.26;12.20;4.89) | 4.39±2.32 (1.00;8.56;4.19) | 4.51±1.26 (1.98;6.41;4.80) | 4.60±2.12 (1.86;10.48;4.23) | 4.65±2.52 (1.28;9.95;4.2) |
| p-value | 0.02* | | 0.00* | | 0.48 | | 0.71 | | 0.65 | |
| L5R | 3.35±1.33 (1.44;6.97;3.16) | 4.02±1.26 (1.98;6.55;4.11) | 3.54±0.98 (1.65;5.47;3.71) | 3.92±0.72 (2.34;5.05;3.91) | 4.96±2.34 (1.66;11.64;4.34) | 5.14±2.97 (2.46;14.00;3.95) | 4.88±3.60 (1.71;17.20;3.40) | 4.50±1.55 (2.01;7.82;4.79) | 4.29±1.75 (1.43;7.68;4.17) | 4.08±2.01 (1.25;8.69;4.00) |
| | 0.04* | | 0.02* | | 0.79 | | 0.59 | | 0.59 | |
| L5L | 3.38±1.37 (1.76;8.14;2.98) | 3.99±1.13 (2.32;7.02;3.95) | 3.70±0.98 (1.86;5.54;3.47) | 4.13±2.32 (2.32;6.08;4.08) | 5.15±2.53 (1.46;12.83;4.51) | 5.01±2.38 (2.29;10.97;4.55) | 4.55±2.32 (1.27;9.29;4.65) | 4.68±1.52 (1.81;6.99;4.79) | 4.43±2.32 (1.75;10.58;3.77) | 4.51±2.39 (1.24;8.81;3.71) |
| p-value | 0.001* | | 0.01* | | 0.71 | | 0.70 | | 0.41 | |
| MT | | | | | | | | | | |
| AST | 28.92±14.66 (0;57;28) | 29.92±16.60 (0;58;29) | 26.98±7.96 (15;54;26) | 26.76±7.66 (15;51;28) | 23;05±18.67 (0;67;26) | 25.81±22.57 (0;90;29) | 27.95±18.51 (0;65;27) | 34.71±22.69 (0;80;31) | 27.95±14.74 (0;62;30) | 30.57±18.62 (0;82;31) |
| p-value | 0.04* | | 0.23 | | 0.14 | | 0.11 | | 0.25 | |
| SRT | 16.72±8.24 (3;30;17) | 14.41±9.21 (4;38;17) | 13.90±7.34 (5;36;11.5) | 16.4±7.38 (6;37;14) | 23.73±10.05 (8;44;21) | 22.23±12.33 (0;41;23) | 23.33±9.89 (10;37;24) | 24.68±8.57 (13;38;28) | 23.21±6.51 (11;38;22) | 21.63±7.57 (0;34;23) |
| p-value | 0.02* | | 0.001* | | 0.65 | | 0.02* | | 0.79 | |

PPT = pressure pain threshold; MT = muscle testing; AST = abdominal strength test; SRT = sit and reach test; MPQ = McGill pain questionnaire.

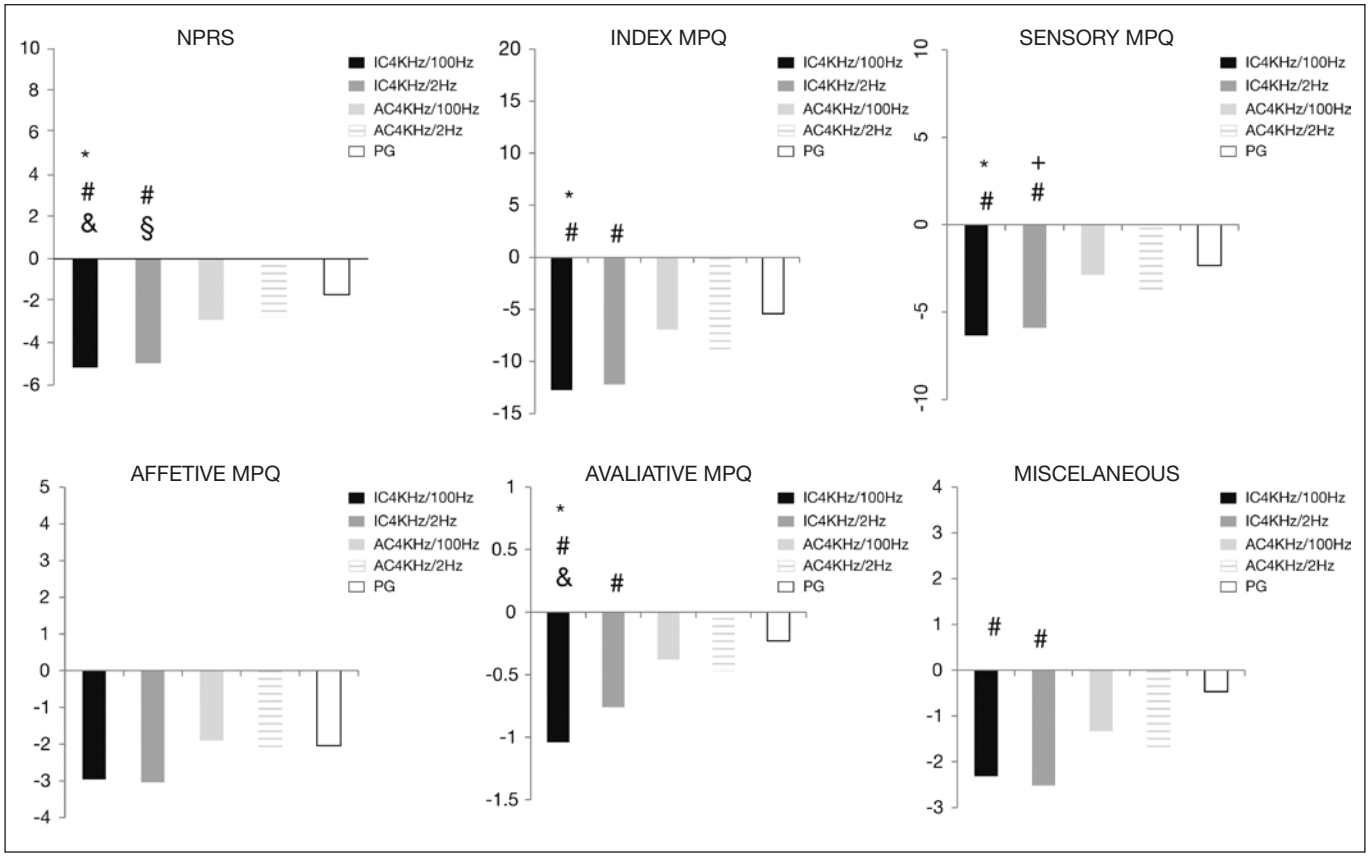


**Figure 2**. Numeric pain scale and McGill pain questionnaire, between groups

*Compared to AC4KHz/100Hz; # compared to PG; & compared to AC4KHz/2Hz; +compared to AC4KHz/100Hz; § compared to AC4KHz/2Hz- (p<0.05, Kruskall Wallis)

**Table 3.** Pressure pain threshold and muscle testing (intergroup).

| | IC 4kHz/100Hz (n=25) Δ mean±SD | IC 4kHz/2Hz (n=25) Δ mean±SD | AC 4kHz/100Hz (n=21) Δ mean±SD | AC 4kHz/2Hz (n=21) Δ mean±SD | PG (n=21) Δ mean±SD |
|---|---|---|---|---|---|
| L3L | 0.55±1.20 | 0.58±0.94 | 0.24±1.40 | 0.37±1.09 | 0.08±0.74 |
| L3R | 0.52±0.91 | 0.49±0.74 | 0.18±1.43 | 0.12±1.51 | 0.05±1.21 |
| L5L | 0.66±1.30 | 0.38±0.71 | 0.18±1.25 | -0.37±2.79 | -0.21±0.94 |
| L5R | 0.60±1.04 | 0.43±0.66 | -0.13±1.31 | 0.12±1.53 | 0.08±1.30 |
| AST | 1.00±2.39 | 0.48±1.89* | 2.76±7.07 | 6.76±8.53 | 2.61±5.35 |
| SRT | 1.48±3.20 | 2.52±2.77 | -1.47±2.74 | 1.38±3.07 | -1.57±8.53 |
| MST | 0.16±0.47 | 0.28±0.54 | 0.76±2.73 | 1.38±3.07 | -0.19±2.52 |
| FTT | 1.32±7.64 | 1.40±2.72 | 3.42±6.36 | 1.47±7.01 | -0.85±6.15 |

Δ= variation between before and after; *p<0.05 compared to PG (Kruskall Wallis test).

## DISCUSSION

The main outcomes found in this study were: low risk of influence of psychosocial factors (40.7%), reduction of pain after the application of both currents (AC and IC). However, only IC showed a significant difference with PG. Regarding functional tests, all groups showed intragroup difference in at least one test, but only IC 4KHz/2Hz showed difference with PG in AST. No differences were found between IC and AC in any of the analyzed outcomes.

It is known that research on the effects of IC is extensive, resulting in several systematic reviews[6,9,10,24-26]; and narratives[4], which observed that IC applied alone has greater analgesic effects when compared to placebo. However, when combined with other treatments, it does not show superior effects. The reviews also showed that IC is not superior to other resources, such as TENS and LASER. Therefore, the results found in this study corroborate the literature, as a greater analgesic effect (NPS and MPQ) was found when compared to PG. In addition to personal and psychosocial factors, altered neuronal activity in brain areas related to pain modulation may

mediate the analgesic effect observed in PG by triggering the release of endogenous opioids. Some studies have shown an association between treatment with placebo and pain reduction due to response expectancy, i.e. when the individual expects a decrease in pain after any form of treatment[9,27]. In the present study, although PG showed a decrease in perceived pain in NPS and MPQ after treatment (intra-group), a significant improvement was observed in IC 4kHz/100Hz and IC 4KHz/2Hz when compared to this group. Parte superior do formulário

In the assessment of pain by pressure algometry, no significant intergroup difference was found, a result in line with a study[28] that investigated the effectiveness of IC before Pilates exercises in reducing pain in patients with CLBP. In their results, no significant differences in pain were found in PPT when compared with PG. Another study evaluated the effect of IC on sensory comfort and its influence on pressure pain threshold in healthy individuals, in which 5 different carrier frequencies (1kHz, 2kHz, 4kHz, 8kHz, 10kHz) were applied and separated into 5 groups. Significant differences in pain outcome were only found in 1kHz group when compared to 8kHz and 10kHz groups. In the other groups, no significant difference was found in PPT[29]. In relation to AC, no study was found that evaluated PPT.

Studies on AC are scarce, mainly on its analgesic effect. One study[12], despite obtaining satisfactory results when analyzing the analgesic effect on low back pain, applied AC to strengthen the muscles of the lumbar spine. Another study[30] applied AC in individuals with neck pain and found no analgesic effect. In this study, no difference in pain was found between AC and PG and also when compared with IC. One study[13] compared the segmental and extra-segmental hyperalgesic effects of interferential current, TENS and Aussie, finding an analgesic effect in all currents, but no difference between them.

It is understood that in the treatment of low back pain, in addition to reducing pain, it is also important to improve functionality. In the present study, only IC 4KHz/2Hz showed a difference with PG in AST, although the other groups showed intragroup differences in all tests. Few studies have evaluated aspects of musculoskeletal functionality after IC or AC application, such as the study[31] that evaluated the effect of IC on the balance of patients with CLBP and observed improvement in this outcome. Thus, more studies are still needed to evaluate not only pain, but also the increase in musculoskeletal function.

This study has some limitations. The first is related to the lack of medium- and long-term follow-up to know if there was no worsening of pain and the second is related to the lack of consensus in the literature on which functional tests are really effective to assess the evolution of treatment and the difference in sample size between the groups.

This research demonstrated that IC was an optimal alternative in immediate analgesia in people with chronic low back pain, unlike AC, for which no significant result was found in relation to PG.

Therefore, IC is of great clinical relevance, representing a low-cost alternative to relieve pain immediately, offering effective application parameters to act concomitantly with kinesiotherapeutic treatment. Furthermore, the importance of further studies to evaluate different electrical currents and application parameters in different age groups and functional tests that are more sensitive for each population is reinforced.

## CONCLUSION

IC provided improvement in subjective pain analysis, regardless of the modulated frequency used. However, the use of electrostimulation modalities (IC and AC) was not superior to placebo in objective pain analysis and functional tests.

## AUTHORS' CONTRIBUTIONS

**Lauana de Paula**
Statistical Analysis, Writing - Preparation of the Original, Writing - Review and Editing, Supervision
**Ayla Colmenarez**
Data Collection, Methodology, Writing - Preparation of the Original
**Felipe Vieira França**
Statistical analysis, Methodology, Writing - Review and Editing
**Filipe Teruo Yamada**
Writing - Preparation of the Original
**Nicole Tafarello**
Data Collection, Writing - Preparation of the Original
**Ana Carolina Brandt de Macedo**
Statistical Analysis, Conceptualization, Project Management, Methodology, Writing - Review and Editing, Supervision

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